REMARKS

The Office Action dated July 1, 2002, was carefully reviewed. It is respectfully requested the Examiner reconsider the present application in light of the remarks herein.

The Examiner rejected claims 1-13 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,089,089 to Hsu. The Examiner also rejected claims 1-18 as being anticipated by U.S. Patent No. 5,922,233 to Clark.

It is respectfully asserted that the present invention is not anticipated by the references cited by the Examiner. The independent claims 1, 5 and 8 of the present invention apply to a cloverleaf micro-gyroscope and require the correction of misalignment and mistuning by way of out-of-plane forces or torques applied by electrostatic biases applied to electrodes lying in a plane (see Figures 1 and 4). At least four planar electrodes are required to operate a closed-loop micro-gyroscope with electrostatic alignment. Cloverleaf micro-gyroscopes are dependent upon out-of-plane motion.

The Hsu and Clark patents are micro-gyroscopes that have in-plane oscillation and correct misalignment and tuning by means of in-plane forces applied with thin finger electrodes. The references cited by the Examiner operate with in-plane motion in the drive axis and sense or output axis direction. These in-plane forces are not effective for aligning and tuning micro-gyroscopes dependent on out-of-plane motion, such as the cloverleaf micro-gyroscope.

It is respectfully asserted that the present invention is not anticipated by either the Hsu reference or the Clark reference. It is respectfully requested the Examiner withdraw the rejections of claims 1-18 under 35 U.S.C. § 102.

The Examiner rejected claims 1-18 under 35 U.S.C. § 103 as being unpatentable over the Clark reference. It is respectfully asserted that the present invention is not obvious in view of the Clark reference.

The present invention is directed to a cloverleaf micro-gyroscope having electrostatic tuning and alignment. The micro-gyroscope is referred to and described in the background of the specification. The specification also refers to a technical paper, (see page 1, line 16), that describes the structure and operation of the cloverleaf micro-gyroscope in great detail.

A cloverleaf micro-gyroscope is a structure consisting of a rim, four silicon leaves and four soft supports that cantilever from the rim. A metal post is rigidly attached to the center of the resonator, in a plane perpendicular to the plane of the silicon leaves, and to a base plate with a pattern of electrodes that corresponds to the pattern of silicon leaves. A resonator plate, defining a plane, and a parallel electrode plane, defined by the electrodes, are separated by a capacitive gap. The resonator has a natural rocking mode vibration axis in the resonator plane.

A cloverleaf micro-gyroscope such as the one described above employs a large resonator plate and depends on out-of-plane motion. The electrodes are large parallel plate capacitors. Out-of-plane motion is motion that is perpendicular to the plane of the sense and drive electrodes.

The Clark reference is a not a cloverleaf micro-gyroscope. The micro-gyroscope taught in the Clark reference operates with in-plane motion in the drive (x) axis and sense or output (z) axis direction. In-plane forces are not effective for aligning or tuning micro-gyroscopes dependent on out-of-plane, or z-axis motion, such as the cloverleaf micro-gyroscope.

Clark teaches the x-axis and y-axis electrodes are fabricated from a single structure layer and many small sensing electrode fingers are positioned to apply in-plane forces to the sense electrodes.

The present invention teaches correcting misalignment/mistuning to zero by out-of-plane forces or torques produced by bias adjustments to a particular planar electrode. This is neither taught, nor is it suggested by the in-plane micro-gyroscope described in the Clark reference.

It is respectfully asserted that the present invention is neither taught nor suggested by the Clark reference. It is respectfully requested the Examiner withdraw the rejection of claims 1-18 under 35 U.S.C. § 103.

The Examiner rejected claims 2-7, 12 and 15-17 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim subject matter of the invention. Specifically, the Examiner indicates the last line of claim 2 is not understood, "sai d drive axis" in claims 2, 4, 12, 15 and 16 lack antecedent basis, " each drive electrode" in claim 16 is unclear and "a stiffness matrix K" in claim 17 is unclear.

Regarding "using a signal in quadrature to rate signal" of claim 2, the claim language should read "us ing a signal in quadrature to a drive axis rate signal". According to the present invention, the drive axis rate signal is in-phase with the modulated inertial rate signal. Appropriate correction has been made in the claim amendments herein.

Regarding "s aid drive axis" for claims 2, 4, 12, 15 and 16, it is respectfully asserted that proper antecedent basis is provided in the preamble of independent claims 1, 5 and 8 which all similarly read, " having closed loop control of drive, output and sense axes."

Regarding claim 17, "a stiffness matrix" for the micro-gyroscope can be explained with reference to the specification beginning at page 8, line 23. The micro-gyroscope has an inertia matrix J, a stiffness matrix K, and a damping matrix D, which define the rotational motion about the x and y axes. The stiffness matrix is shown mathematically at page 10, line 8.

It is respectfully requested the Examiner withdraw the rejections of claims 2-7, 12 and 15-17 under 35 U.S.C. § 112 in light of the clarification provided herein.

Should the Examiner have any questions or comments that may place the application in better condition for allowance, he is respectfully requested to call the undersigned attorney.

Respectfully submitted,

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"VERSION WITH MARKINGS TO SHOW CHANGES MADE"

Kindly substitute the following for pending claim 1:

1. (Amended) A method for aligning a cloverleaf micro-gyroscope having a resonator in a resonator plane, at least four electrodes in an electrode plane adjacent said resonator plane, and closed loop control of drive[,] and output [and sense] axes, said method comprising the steps of:

detecting misalignment of an axis of natural vibration of said [micro-gyroscope] resonator relative to said drive axis; and

correcting misalignment to zero by an electrostatic bias adjustment applied to an electrode to produce a force perpendicular to the electrode plane.

Kindly substitute the following for pending claim 2:

2. (Amended) The method as claimed in claim 1 wherein said step of detecting misalignment further comprises detecting misalignment by way of quadrature signal amplitude obtained by demodulation of a signal of said output axis using a signal in quadrature to a drive axis rate signal [for said drive axis].

Kindly substitute the following for pending claim 5:

5. (Amended) A method for tuning a cloverleaf micro-gyroscope having a resonator in a resonator plane, at least four electrodes in an electrode plane adjacent said resonator plane, and closed loop control of drive[,] and output [and sense] axes, said method comprising the steps of:

detecting residual mistuning by way of a signal; and

correcting said residual mistuning to zero by way of electrostatic bias adjustment applied to an electrode to produce a force perpendicular to the electrode plane.

Kindly substitute the following for pending claim 8:

8. (Amended) A method for independently aligning and tuning a cloverleaf micro-gyroscope having a resonator in a resonator plane, at least four electrodes in an electrode plane adjacent said resonator plane, and closed loop control of drive[,] and output [and sense] axes, said method comprising the steps of:

detecting misalignment of an axis of natural vibration of said [micro-gyroscope] resonator relative to said drive axis; and

correcting misalignment to zero by an electrostatic bias adjustment applied to an electrode to produce a force perpendicular to said electrode plane;

detecting a residual mistuning by way of a signal; and

correcting said residual mistuning by way of an electrostatic bias adjustment applied to an electrode to produce a force perpendicular to said electrode plane.

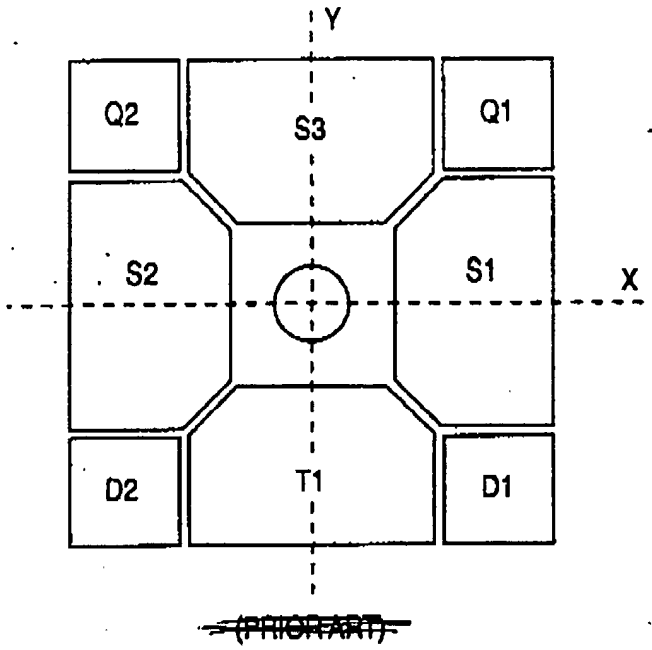
Y
Q2
S3
Q1
50
S2
S1
X
D2
T1
D1
(PRIOR ART)

FIG.4

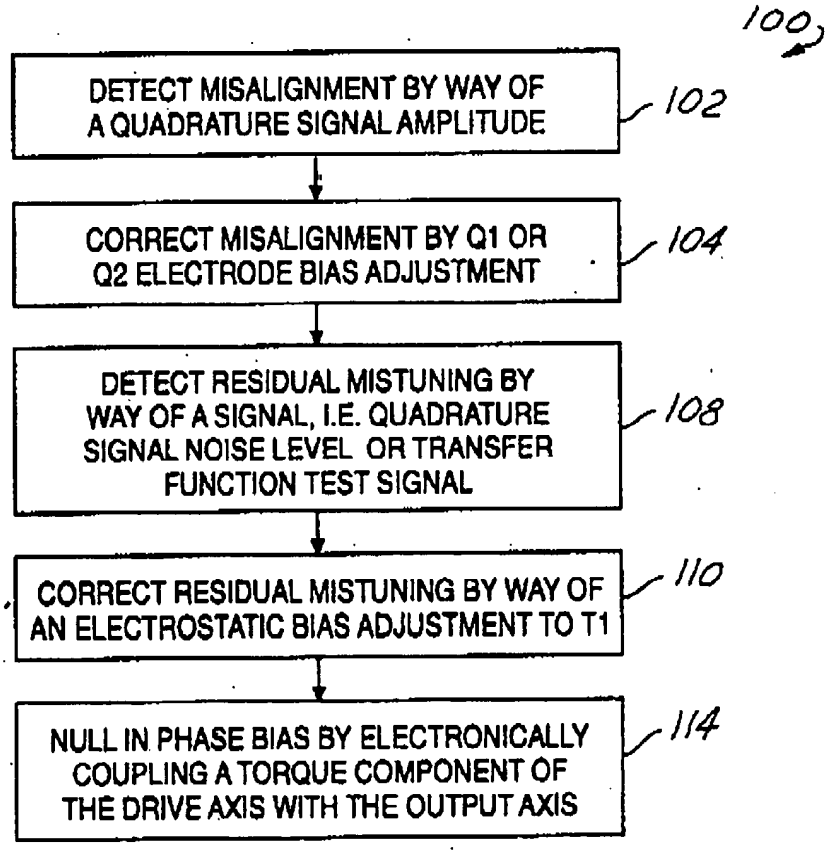
100
DETECT MISALIGNMENT BY WAY OF A QUADRATURE SIGNAL AMPLITUDE
102
CORRECT MISALIGNMENT BY Q1 OR Q2 ELECTRODE BIAS ADJUSTMENT
104
DETECT RESIDUAL MISTUNING BY WAY OF A SIGNAL, I.E. QUADRATURE SIGNAL NOISE LEVEL OR TRANSFER FUNCTION TEST SIGNAL
108
CORRECT RESIDUAL MISTUNING BY WAY OF AN ELECTROSTATIC BIAS ADJUSTMENT TO T1
110
NULL IN PHASE BIAS BY ELECTRONICALLY COUPLING A TORQUE COMPONENT OF THE DRIVE AXIS WITH THE OUTPUT AXIS
114

FIG.5